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The effects of clinical wear on the incidence of temporomandibular disorders among patients with complete dentures

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الملخص

أهداف البحث: قيّمت هذه الدراسة أثر التآكل السريري على نسبة حدوث اضطرابات في المفصل الصدغي الفكي في من لديهم أطقم أسنان كاملة.

طرق البحث: أُجريت دراسة سريرية عشوائية على مجموعتين: شملت المجموعة الأولى؛ ٣٠ مريضا تلقوا أطقم أسنان كاملة للفكين العلوي والسفلي مصنوعة من الراتين الاكريليكي المتصلب بالحرارة, وشملت المجموعة الثانية؛ ٢٩ مريضا تلقوا أطقم أسنان كاملة للفكين العلوي والسفلي مصنوعة من الخزف. تم تقييم كل من نسبة الحدوث والفحص السريري لاضطرابات المفصل الصدغي الفكي باستخدام مؤشر هيلكيمو للاختلال الادكاري، ومؤشر هيلكيمو للاختلال السريري على التوالي. وقُدر تآكل أسنان التركيبات بتقييم عمق التآكل باستخدام متوسط الفوارق بين صور المتابعة للشرفة اللسانية في كل زيارة. كان توقيت زيارات المتابعة لتقييم التآكل واضطرابات المفصل الصدغي الفكي عند ٦ و١٢ و ١٨ و ٢٤ شهرا.

النتائج: تعرض أصحاب أطقم الراتين الاكريليكي المتصلب بالحرارة لتآكل أكثر منه في مجموعة الأطقم الخزفية, وبشكل واضح, وذلك عند الشهور١٢ و١٨ و٢٤ من المتابعة. كما أن نسبة اضطرابات المفصل الصدغي الفكي في مجموعة أطقم الراتين الاكريليكي المتصلب بالحرارة، كانت أكثر منها في مجموعة الأطقم الخزفية عند الشهور ١٨ و٢٤ من المتابعة وبشكل واضح.

الاستنتاجات: نسبة الإصابة باضطرابات المفصل الصدغي الفكي عند من لديهم أطقم أسنان كاملة ومصنوعة من الراتين الاكريليكي المتصلب بالحرارة أكثر من نسبتها في أصحاب الأطقم الخزفية.

الكلمات المفتاحية: الراتين الاكريليكي؛ التآكل السريري؛ الأطقم الكاملة؛ الخزف؛ اضطرابات المفصل الصدغي الفكي

Abstract

Objective: This study evaluates the effect of clinical wear on the incidence of temporomandibular disorders in patients with complete dentures.

Methods: A randomized clinical trial was conducted on two groups; group 1 (30 patients) received complete upper and lower dentures with teeth made of heat-cured acrylic resin, and group 2 (29 patients) received complete upper and lower dentures with teeth fabricated of porcelain. The occurrence and clinical examination of temporomandibular disorders were evaluated using Helkimo anamnestic dysfunction index (Ai) and Helkimo clinical dysfunction index (Di), respectively. Clinical wear of denture teeth was estimated by the assessment of wear depth using the mean differences between tracing images of lingual cusps at each follow-up. The patients were followed up at 6, 12, 18 and 24 months for assessment of clinical wear and incidence of temporomandibular disorders.

Results: The acrylic resin group was subjected to significantly higher wear than the porcelain group at 12, 18 and 24 months of follow-up. The incidence of temporomandibular disorders was also significantly higher in the acrylic resin group than in the porcelain group at 18 and 24 months of follow-up.

Conclusion: There was higher incidence of temporomandibular disorders among patients who wore complete dentures with teeth made of acrylic resin than in patients who wore complete dentures with porcelain teeth.

Keywords: Acrylic resin; Clinical wear; Complete denture; Porcelain; Temporomandibular disorders

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Introduction

A complete denture is considered insufficient if there is a lack of stability, if it has poor retention or if there is a loss of vertical dimension. Loss of vertical dimension could be a result of inaccurate fabrication or of artificial teeth wear.[1] This disturbs the stomatognathic system because vertical dimension loss could be exacerbated with prolonged use of inadequate denture.[2] Additional vertical dimension loss and increased horizontal stress could affect the health of the masticatory system.[3]

Clinical wear of denture teeth is usually expected in patients after years of denture use. Posterior teeth seem to be more affected by food abrasion. Development of facets in the anterior teeth due to attrition (tooth to tooth contact) usually occurs. A positive relationship has been found between the duration of complete denture wearing and the incidence of temporomandibular disorder (TMD).[4] The patients wearing complete dentures could be subjected to unbalanced distribution of occlusal force as a result of abrasion affecting posterior teeth in addition to attrition, which usually occurs in anterior teeth. After five years of use, approximately half of complete denture patients require replacement.[5] Extensive wear of denture teeth could affect the patient's quality of life through harmful impact on the masticatory system.[6]

Denture teeth made of acrylic resin usually show progressive occlusal wear, which could lead to rapid loss of vertical dimension. Three types of wear have been suggested: frictional wear, adhesive wear and abrasive wear.[7] In vitro studies aiming to measure wear of denture teeth have the drawback of assessing abrasive wear only under a few conditions,[8,9] while clinical trials could yield more comprehensive assessment.

Artificial teeth are commonly made from two types of material: acrylic resin and porcelain. Porcelain is well known for its stability against wear and resistance against abrasive forces. Denture teeth made of porcelain can act as a control for acrylic resin teeth because they are highly resistant to abrasive forces and are considered to be more stable against wear.[10–13]

This study aims to assess the role of clinical wear in incidence of TMD among complete denture patients.

Materials and Methods

Randomized clinical trial, parallel arm design was conducted at the Faculty of Dentistry, University of Khartoum, Sudan, from January 2014 to January 2016.

The main inclusion criteria were edentulous patients in need of complete dentures. Patients with severe malocclusion or patients with the following diseases were excluded; systematic diseases affecting TMD like generalized fibromyalgia, rheumatoid arthritis or post-traumatic stress disorder. Eligible patients gave written informed consents in order to be included in this study. A post hoc power analysis conducted by Ogle and Davis indicates that a sample size of 27 patients in each study group is the minimum sample size required for detection of 0.05 mm at a 95% confidence level and statistical power equal to 0.80.[7] Therefore, 64 patients were included in this study (32 patients in each group) in order to provide sufficient statistical power and compensate for withdrawal rate. The patients who agreed to participate in this study were assigned to two groups using random table numbers. Group 1 represented the intervention group, where patients received complete upper and lower dentures with teeth made of heat cure acrylic resin (Meliodent, Bayer dental, Germany batch no 54105L-2). Group 2 represented the control group, where patients received complete upper and lower dentures with teeth fabricated of porcelain (dent supply, Germany batch no 43105L-1). Five patients who were non-compliant were excluded from final result analysis: two patients belonged to group 1, and three patients to group 2.

The patients were followed for two years at 6, 12, 18 and 24 months for assessment of clinical wear and incidence of TMD. The initial visits after denture insertion were devoted to denture modification until the patient became well adapted to the denture. After patients were well adapted to the denture, the following visit was considered a baseline assessment visit, where measurement of clinical wear and assessment of TMD started. The clinical examination of TMD was conducted according to the Helkimo clinical dysfunction index (Di). The occurrence of TMD was evaluated by a questionnaire based on the Helkimo anamnestic dysfunction index (Ai). Questions about demographic variables such as age, gender, income and educational level were added to the questionnaire. Confounding factors such as awareness of bruxism, complete denture wearing (either worn continuously or taking it off during the night), stressful life style and presence of preferred chewing side were included.

Clinical wear of denture teeth was evaluated in this study by assessment of wear depth. Although a computer graphic measuring system has been used by in vitro studies to measure volumetric loss, it was considered to be time-consuming for this study. Instead, the depth of tooth wear was measured. The method used by Satoh et al. was used because it was found to be more time and cost effective. The anatomy of the lingual cusp was traced in the buccolingual direction by an apparatus using tracing head speed equal to 0.3 mm/s with 50 pm diameter at 20 times magnification. Then, every traced image was analysed by a computerized system with a special camera with pixels of H512 × V512.[14]

The image of each follow up visit was analysed and compared with the image of the baseline measurement. The depth of wear affecting posterior denture teeth was calculated based on the difference between the two images, shown by a line drawn from the apex of palatal or lingual cusp in the baseline record to that of subsequent follow-up visits. Then, the lengths of all lines drawn in all posterior teeth were averaged to calculate the mean length for each follow up visit. This mean length was divided by 20 (the image enlargement ratio) to obtain the mean of overall depth of clinical wear per patient in each follow-up visit.

Two examiners, who conducted the questionnaire interview and the clinical examination of TMD, were calibrated with a Kappa index of 0.82, which is considered a good reliability level for examination results. Duplicate measurements of clinical wear were conducted at the baseline assessment of the study to estimate the measurement method's reliability. The resultant error of clinical wear

measurement was small (0.015 mm) and could not affect the reliability of measurements.

The data were analysed by computerized method; (Statistical Package for Social Sciences) (SPSS version 20), and P-values less than 0.05 were considered to be statistically significant. Descriptive statistics were used to describe demographic characteristics in both study groups; chi-square and t-tests were used to detect significant differences. Average data of clinical wear were calculated per patient throughout the follow-up visits. The direct association between total clinical wear and TMD presence throughout follow-up visits used repeated-measures ANOVA. A logistic regression was conducted to control for factors that may confound the association between clinical wear and TMD presence; TMD presence was a dependent variable, while denture teeth material in addition to gender, awareness of bruxism, presence of preferred chewing side, wearing denture at night and stressful life style were independent variables.

Results

A total of 59 patients were included in the results after the exclusion of five non-compliant patients: the acrylic resin group included 30 patients, and the porcelain group included 29 patients. Table 1 demonstrates the demographical characteristics of study participants. There were no statistically significant differences regarding demographical characteristics between patients with complete denture teeth made of acrylic resin or of porcelain.

Mean clinical wear was estimated at 6, 12, 18 and 24 months for each group. The findings are shown in Figure 1, which demonstrates that the mean of clinical wear rose linearly in both groups with time. Comparing the mean values of clinical wear by Mann–Whitney test showed that, as expected, the acrylic resin group was subjected to significantly higher wear than the porcelain group at 12, 18 and 24 months of follow-up. Additionally, the incidence of TMD showed a noticeable increase with time, especially in the acrylic resin group. The difference in TMD incidence started to be significantly higher in the acrylic resin group rather than in the porcelain group at 18 and 24 months of follow-up (Table 2). Direct association between mean clinical wear and incidence of TMD in all study participants was assessed using repeated-measures ANOVA. The mean value of clinical wear in each follow-up visit showed non-significant association with TMD incidence (P = 0.16). Multivariate analysis using a multiple logistic regression model demonstrated two significant predictors of TMD incidence: the material of denture teeth and the presence of a preferred chewing side (Table 3).

Table 1: Distribution of demographic characteristics in intervention and control groups.

Material of denture teeth		Denture teeth made of acrylic resin (n = 30)	Denture teeth made of porcelain (n = 25)	P-value
Gender	Male	13 (43%)	11 (38%)	0.673
	Female	17 (57%)	18 (62%)	
Education	Illiterate	6 (20%)	7 (24%)	0.701
	Literate	24 (80%)	22 (76%)	
Age (mean ± sd)		51 ± 3.7	54 ± 4.2	0.530

Discussion

To the best of our knowledge, no study has investigated the direct association between clinical wear of denture teeth and TMD incidence. In this study, direct association between mean value of clinical wear and TMD incidence was found statistically non-significant (P = 0.16). This could be due to the relatively small sample size used in this study or the short time of follow up (only 2 years). Because acrylic resin was subjected to higher wear, while porcelain was well known for its resistance, the material of denture teeth was used in this study as a proxy variable that could, to some extent, replace the clinical wear variable. The presence of significantly higher incidence of TMD among the acrylic resin group after 18 and 24 months of denture use could be partially explained by the higher clinical wear that affected that group. The presence of this association could be supported by a steady increase in TMD incidence, especially among the acrylic resin group, which was subjected to significantly higher clinical wear than the porcelain group. Harrison finds that denture teeth made of acrylic resin could be affected by a higher level of wear than porcelain ones. In the 2 years of denture use, clinical wear affecting porcelain teeth did not exceed 0.076 mm, while in acrylic resin teeth it reached 0.279 mm in the same period.[10]

The occurrence of TMD is multifactorial, which includes physical risk factors, occlusal disharmony, psycho-social problems or presence of systemic diseases,[4] therefore the presence of an association between clinical wear and TMD incidence could be confounded by numerous other factors. Therefore, logistic regression was used to model the effect of denture teeth material side by side with well-known risk factors of TMD. The risk ratio of the acrylic resin group was found to be 2.34, which means that patients with TMD were 2.34 times more likely to be of the acrylic resin group than

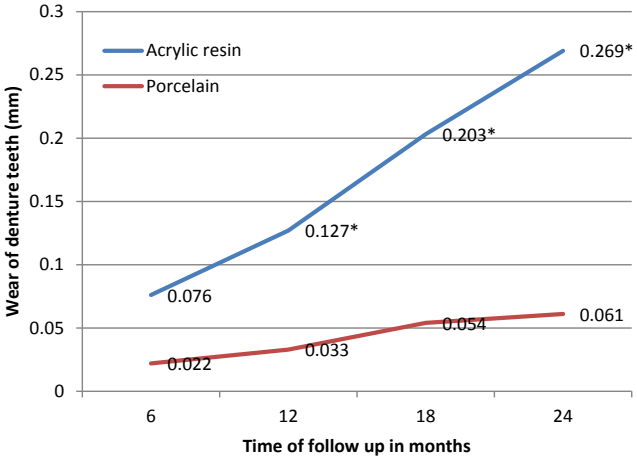

Figure 1: Clinical wear affecting acrylic resin and porcelain denture teeth throughout follow-up.
*Clinical wear was significantly different between group 1 and group 2.

Table 2: Incidence of TMD in both groups throughout time of follow-up.

Duration	TMD incidence		Risk ratio	Chi-square	P-value
	Acrylic (n = 30)	Porcelain (n = 29)			
6 months	1 (3%)	3 (10%)	0.33	1.147	0.284
12 months	5 (17%)	3 (10%)	1.67	0.503	0.478
18 months	11 (36%)	4 (14%)	2.75	4.069	0.044
24 months	13 (43%)	5 (17%)	2.60	4.735	0.030

Table 3: Logistic regression model of multiple risk factors that could influence cumulative TMD incidence after 24 months of follow-up.

Predictors		TMD incidence (odds ratio)	P-value
Denture teeth material (reference group was the porcelain group)	Acrylic resin	2.34	0.037
Gender (reference group is female)	Male	0.89	0.671
Awareness of bruxism (reference group was not aware)	Yes	1.37	0.220
Presence of preferred chewing side (reference group had no preferred chewing side)	Yes	2.17	0.042
Wearing denture at night (reference group who does not wear denture at night)	Yes	1.15	0.519
Stressful life style (reference group said they do not have a stressful life)	Yes	1.03	0.701

from the porcelain group. Seghi suggests that a dental material must have a wear resistance close to that of tooth; otherwise, it could lead to functional problems like TMD.[15]

The presence of a preferred chewing side was found to be significantly associated with TMD occurrence with a risk ratio of 2.71. In other words, a patient with TMD was 2.71 times more likely to be among those who had preferred chewing side than those who had none. While Ogle and Davis find no significant difference in overall wear between preferred and non-preferred chewing sides, their study aims to compare the clinical wear in three different types of acrylic resin among patients wearing complete dentures for 36 months. They find that gender and tooth material had no significant effect on clinical wear in a group of 55 complete denture patients.[7] The present study shows no significant difference in TMD occurrence by gender, while Dallnora et al. find a gender difference, with more women than men requiring healthcare for TMD.[4]

Dervis assesses the occurrence of TMD 3 months before, 3 months after, and 3 years after the insertion of a complete denture. He finds a reduction in TMD prevalence before and after complete denture insertion, but no statistically significant difference.[1] Abdelnabi et al. find that renewal of complete dentures would significantly improve the status of TMD in symptomatic denture wearers.[16] Dallanora et al. conduct a retrospective study and determine the prevalence (50%) of TMD among a sample of 44 patients using acrylic resin denture for a period of 1–5 and 5–10 years.[4] In another study in Sweden, 46% of complete denture wearers presented with TMD; Helkimo also finds a TMD prevalence of 57%.[17] These findings are similar to those of the present study, which finds a prevalence of 43% after 2 years of complete denture use. The fixed prevalence rate over 5–10 years of denture use in Dallanora et al.'s study reflects the importance of the first years in the occurrence of TMD. Factors such as improper denture design or clinical wear affecting denture could initiate TMD after a few years of use, although Ettinger et al. find no relation between prosthetic status and TMD occurrence.[18]

In contradicting results found by Wilding and Owen, a lower prevalence of TMD (24%) was found among edentulous non-denture wearing seniors when compared with denture wearing seniors. They postulate that mastication at a decreased vertical height is not associated with the development of TMD.[19] However, the lower prevalence of TMD reported by Wilding and Owen could be due to other causes, such as younger patients (mean 45 years old). Additionally, patients had well-preserved alveolar ridges, as reported, "patients could chew in a satisfactory manner." A Brazilian study reported the prevalence of signs and symptoms of TMD; the researchers found the prevalence of pain in the masseter muscle area in 39% and joint sounds in 24% of 84 patients wearing complete upper and lower dentures.[13] Discrepancies in TMD prevalence could be attributed to different methods of assessment used by different studies.

The major limitation of this study is the short time of follow up because 24 months cannot be considered as an optimal period to follow complete denture patients in order to assess a multifactorial disorder like TMD.

Conclusions

There was no significant direct association between clinical wear and incidence of TMD among complete denture patients. However, there was a higher incidence of TMD among patients wearing complete dentures with artificial teeth made of acrylic resin in comparison with those wearing complete dentures with teeth made of porcelain. The clinical wear affecting acrylic resin teeth was significantly higher than that affecting artificial teeth made of porcelain. Additionally, patients with a preferred chewing side were subjected to higher incidence of TMD.

Conflict of interest

The author has no conflict of interest to declare.

Ethical clearance

Ethical clearance was obtained by the technical and ethical committee at the University of Khartoum. The study

was registered in the International Standard Randomized Controlled Trials Number (ISRCTN) registry with study ID ISRCTN27154312.

Authors' contributions

KAA is the sole author of the study. He conceived and designed the study, conducted research, provided research materials, and collected and organized data. He also analyzed, interpreted data and wrote initial and final draft of article, and provided logistic support. He has critically reviewed and approved the final draft and is responsible for the content and similarity index of the manuscript.

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